# Carbon Monoxide Levels at Selected Intersections in the City of Long Beach, California

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## Introduction

Carbon monoxide is an orderless, lethal gas. Pedestrians and drivers may be subjected to great amounts of this gas especially at traffic intersections. During the summer of 1978 carbon monoxide levels were measured at several intersections in the city of Long Beach, California.

Long Beach is situated in a Mediterranean climatic type adjacent to the cool waters of the Pacific Ocean. During the summer the city is under the eastern edge of the Pacific Sub-tropical high pressure ridge; therefore, generally dry summers prevail because of the double inversion situation. However, rain from downgraded Pacific tropical storms and thunderstorms does on occasion occur. The high pressure ridge weakens and migrates to the south in winter, and North Pacific storms can frequent the region.

The city has a population of 350,000 and covers an area of 130 square kilometers (50 square miles). Long Beach is one of the major urban areas in Greater Los Angeles and is surrounded on three sides by other municipalities. Air pollution monitoring is provided by the South Coast Air Quality Management District with its network of 38 stations for the southern counties. The south coast station is situated near the San Diego Freeway on Long Beach Boulevard (see Fig. 1), in the western section of the city. This air monitoring station not only serves Long Beach, but the surrounding cities as well. Representativeness of readings and forecasts for the city as a whole as provided by this station is, therefore, questionable, not only because of the large size of the area that it serves, but also because of a variety of situations that are faced at different locations.

## Procedure

Concentrations of carbon monoxide were measured on an Interscan Portable Analyser #1148, and recorded on a Rustrak Recorder #288 at four major traffic intersections, as illustrated in Figs. 2-A, B, C and D. The analyser was placed about one meter from the ground and was faced toward traffic. Carbon monoxide levels were then measured for 10 minutes. Observations were made on both sides of the street at intersections to note differences in the windward-leeward

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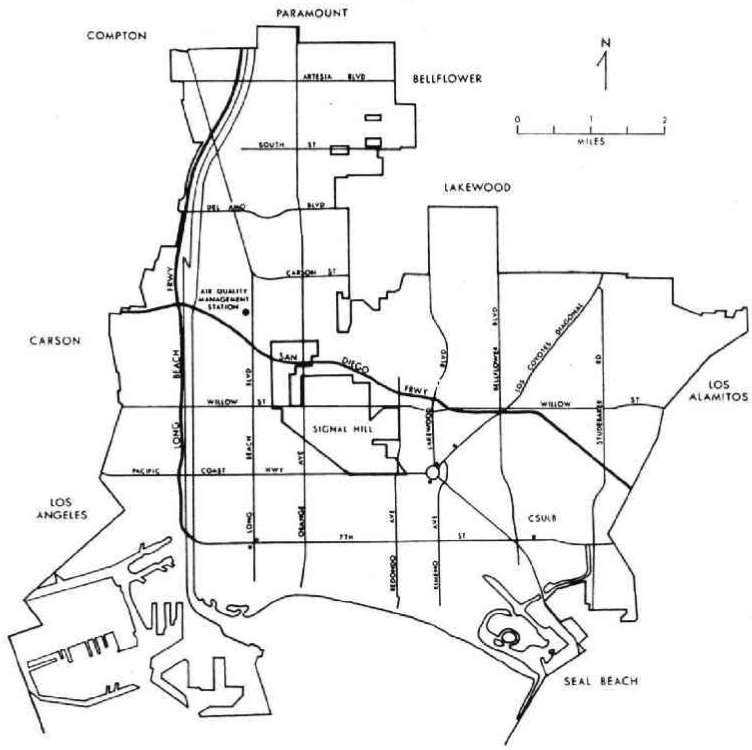


Fig. 1 Road networks in the City of Long Beach

concentrations. The major streets in Long Beach have four traffic lanes. The analyser was placed on sidewalks nearest to the streets. Temperatures and winds were also observed (Table 1). Traffic data were supplied by the City of Long Beach, Division of Transportation and Engineering. Traffic counts were not made at the time of observation because the Traffic Department had made intensive studies regarding traffic volume and such data appeared to be sufficient. As Table 1 indicates, the dates of the traffic counts are not current; however, there was no reason to believe that these figures were obsolete.

## Carbon monoxide levels at selected intersections

Brief, Jones and Yoder (1960) and McCormick and Xintras (1962) agree that qualitative correlation exists between traffic count and carbon monoxide concentration; however, McCormick and Xintras (1962) note that statistical correlation was not impressive. They state, in addition, that simple hourly traffic counts do not represent adequately source strength variations and/or that the meteorological

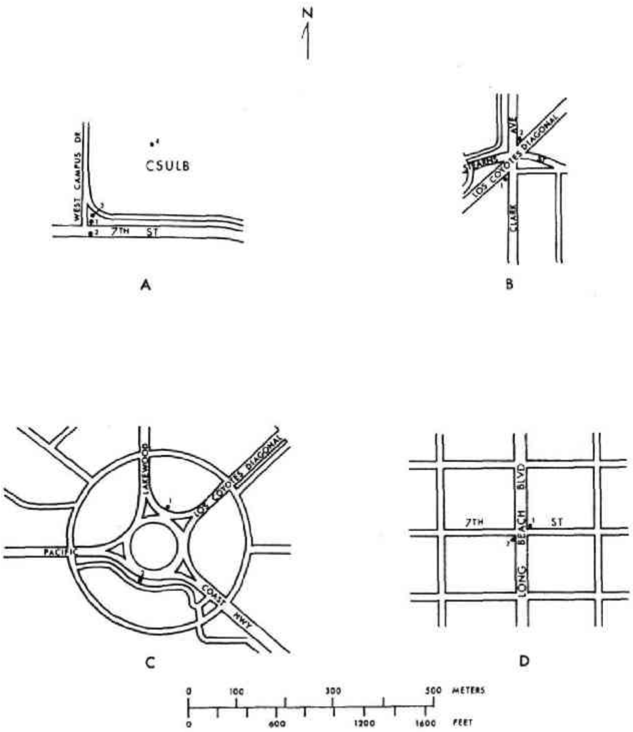


Fig. 2 Selected Intersections in the City

influences on observed carbon monoxide concentrations are important. In addition to any natural wind that may exist, passing cars create gusts and flurries that unquestionably play an important role in the local dispersion of exhausted gasses and particulates. Tiao, Box and Hamming (1975) estimate several parameters regarding average carbon monoxide of which wind was one of the variables.

With the exception of large vehicles, it was noted that while automobiles were travelling at a steady rate of speed carbon monoxide levels were for the most part below 5 ppm. As vehicles began to accelerate after being stopped at signals carbon monoxide levels reached peak levels. It was also evident that while wind has a tendency to dissipate, it could have the effect of concentrating pollution as well. This is especially true if the wind crosses a street. While the lee side of the street may have low levels, the windward side may record high values.

Observations were made at the following intersections in the City of Long Beach:

**A.** Fig. 2-A illustrates the intersection of East Seventh Street and West Campus

Table 1 Carbon monoxide, wind,

| Monit. Sta.* | CO (ppm) at Intersections | | | | Temp. |
|---|---|---|---|---|---|
| Av. CO (ppm) | Site | Peak | Av. | Low | °C |
| **A** East Seventh and West Campus Drive | | | | | |
| 3.3 | 1 | 18 | 4.3 | 0.0 | 25 |
| | 2 | 3.2 | 1.5 | 0.0 | 24 |
| | 3 | 9.8 | 3.3 | 0.7 | 25 |
| | 4 | 1.5 | 0.5 | 0.0 | 24 |
| **B** Clark, Los Coyotes and Stearns | | | | | |
| 3 | 1 | 20.5 | 5 | 0.5 | 24 |
| | 2 | 21.5 | 4.5 | 0.5 | 25 |
| **C** Pacific Coast Highway Traffic Circle | | | | | |
| 2.5 | 1 | 8 | 2.5 | 0.0 | 24 |
| | 2 | 4 | 1.5 | 0.0 | 22 |
| **D** Seventh and Long Beach Boulevard | | | | | |
| 4 | 1 | 34 | 6.5 | 1.5 | 26 |
| | 2 | 24 | 4.0 | 1.0 | 27 |

Source: * South Coast Air Quality Management Distric
** City of Long Beach, Division of Transportation

Drive. California State University, Long Beach, fronts on East Seventh Street. West Campus Drive is an access street to the University. Because classes were not in session, traffic on West Campus Drive was minimal. Site 1 was selected at the traffic signal on the north side of Seventh Street. The wind was southwesterly, diagonally across Seventh Street, with a velocity of 2.75 mps. Therefore, exhaust from the opposing lanes too was monitored. Because the traffic signal favors Seventh Street, and vehicles were not often stopped at the signal, there were few incidents of high values. However, peak values were noted when vehicles that were stopped at the signal began to accelerate, or when large vehicles passed. The highest reading was 25 ppm, with an average peak of 18. However, despite heavy traffic the average was only 4.3 ppm with zero being recorded on occasion. At site 2, on the south side of Seventh Street, the values were significantly lower. The mean peak reading was 3.2 ppm, while the average was 1.5. Because the wind was southwesterly, carbon monoxide was being transported away from this site, which kept the readings low.

temperature and traffic

| Wind | | Traffic** | | | |
|---|---|---|---|---|---|
| Dir. | Vel. (mps) | Date | Direction | Count (1500–1600 hrs) | Total |
| SW | 2.75 | 3-23-77 | West only | 1500 | 25, 941 |
| SW | 4.2 | 11-18-74 | East | 1698 | 21, 457 |
| | | | West | 1136 | 22, 127 |
| SSW | 3.1 | Clark 10-26-77 | North | 419 | 6, 918 |
| | | | South | 413 | 5, 846 |
| | | Los Coyotes 5-9-72 | East | 717 | 5, 962 |
| | | | West | 467 | 7, 318 |
| SW | 2.9 | Stearns 5-10-72 | East | 92 | 4, 179 |
| | | | West | 94 | 4, 948 |
| WSW | 1.5 | 7-29-76 | West one-way | 904 | 14. 549 |
| WSW | 1.8 | 7-29-76 | East one-way | 1192 | 16, 417 |
| SSW | 1.75 | 3-10-77 | West one-way | 845 | 14, 509 |
| | | | North | 701 | 8, 776 |
| S | 1.0 | 3-10-77 | South | 684 | 9, 777 |

and Engineering

Site 3 was situated twenty meters from the north side of Seventh Street and 5 meters from West Campus Drive. Compared with site 1, there is almost a 50% decrease in the average peak value, while the mean shows about a quarter as much concentration of carbon monoxide. Beach (1971) discusses a Russian study indicating a reduction of carbon monoxide to be 44% at a distance 22 meters from the edge of a road. Site 4 was placed approximately 200 meters from Seventh Street, which was situated in the middle of the upper-campus. Readings of carbon monoxide were extremely and consistently low. For example, the average peak value was only 1.5 ppm, with a mean of 0.5 ppm.

**B.** Carbon monoxide was measured at the intersection of Clark Avenue, Los Coyotes Diagonal and Stearns Street. Observation sites were placed between Clark Avenue and Los Coyotes Diagonal on both the northeast and southwest corners of the intersection (Fig. 2-B). At site 1, it was evident that when the wind was southerly, paralleling Clark Avenue, the peak values were relatively low (7 ppm); however, when the wind was southwesterly, paralleling Los Coyotes Diagonal, a high of 34 ppm was noted. The mean, however, of the two observations was 5 ppm. The wind velocity was 3.1 mps. This site primarily measured the northbound traffic on Clark Avenue (419 units between 1500 and 1600 hours), and the eastbound traffic on Los Coyotes which had almost twice the traffic volume as Clark. Carbon monoxide levels on the northeast corner of the intersection (site 2) was relatively high primarily because under southerly and southwesterly wind conditions, this site was not only monitoring exhaust from traffic travelling in both directions on Los Coyotes Diagonal, but from the north bound lanes of Clark Avenue as well. Traffic on Stearns Street was light; therefore, vehicles on this street played no significant role in contributing to the carbon monoxide levels.

**C.** Observation sites were set up on the north side of the Pacific Coast Highway Traffic Circle between Lakewood Boulevard and Los Coyotes Diagonal (site 1, Fig. 2–C), and site 2 was situated on the south side of the Circle. The wind was primarily west-southwesterly at both sites; therefore, windward at site 1 and leeward at site 2. Table 1 indicates that carbon monoxide levels at site 1 were relatively low despite the moderate to high traffic volume. This resulted because the wind was over the park enclosed by the Traffic Circle and traffic movement was continuous. At site 2, the wind was leeward of the monitoring site, and despite the heavier traffic volume than at site 1, carbon monoxide levels were lower.

**D.** The intersection of Seventh Street and Long Beach Boulevard is approximately one kilometer from the center of downtown Long Beach. Sites were established on the northeast corner on Seventh Street and on the southwest portion of the intersection on Long Beach Boulevard. At site 1, the wind was south-southwesterly at 1.75 mps, and at site 2 the wind was from the south at 1.0 mps. At this location, Seventh Street is a one-way street (west bound with a volume of 845 vehicles between 1500 and 1600 hours). Because of the wind direction, site 1 not only received vehicular exhaust from Seventh Street, but from Long Beach Boulevard as well. On the other hand, site 2 monitored carbon monoxide only from traffic on Long Beach Boulevard, primarily from the south-bound lanes. Therefore, site 1 had a higher peak and mean readings than site 2. It should be noted that the high peak readings were evident when large vehicles passed or when vehicles were in the stage of acceleration. The proximity to the downtown location seemed to have no effect on the high levels of carbon monoxide; however, it was noted that there were fewer frequencies of very low readings. The heavy traffic and congenstion may have contributed a maximum of 2 to 3 ppm to the levels a kilometer away.

## Representativeness of the air monitoring station

For the City of Long Beach and the surrounding area, air pollution monitoring is provided by a single monitoring station which is situated some five kilometers from downtown Long Beach. Table 1, Column 1 shows the average carbon monoxide levels as reported by this station for the hours 1500 to 1600 on the dates on which carbon monoxide concentrations were measured at the above four traffic intersections. The table shows that while there appears to be no significant difference between the means, this may not be the case for the peak or instantaneous values. Moreover, the monitoring station is situated on the west side of Long Beach Boulevard. While the traffic volume is heavy (1,800 vehicles for the hours 1500 to 1600, with a daily volume of nearly 24,000), the prevailing wind is southwesterly; therefore, this station is situated on the leeward side of the street. Ott and Eliassen (1973) report that the monitoring station in San Jose, California drastically underestimates the carbon monoxide that is subjected to pedestrians in the downtown area, and overestimates the values for the city as a whole. Ramsey (1966), notes that in his studies of carbon monoxide in Dayton, Ohio, intersections along major arteries somewhat removed from downtown locations often provide the greatest concentration, possibly because of the greater number of traffic lanes. In Southern California as in the nation, if not the world, the density of air-monitoring stations should be increased to provide a more representative condition for the neighborhoods.

## Conclusion

It is evident that traffic volume and carbon monoxide concentrations are related; however, there appears to be significant variables which are not only meteorological in nature. Variations of carbon monoxide levels were affected by the size of the vehicles as well as by the steadiness of the speeds at which the vehicles were travelling. Significant increases were noted in carbon monoxide levels when vehicles began to accelerate.

Winds also play an important role in concentrating and in dissipating pollution. It is felt that the stronger the wind, the greater the dissipation; however, under weaker wind conditions with a steady direction, concentration of pollution could result in windward locations. Although this study was conducted in an area with single and two-story structures, wind channeling by the buildings, trees and the streets was evident. Surface temperature observations were made; however, abovesurface temperature data were not gathered. For this reason, atmospheric stability was not determined.

### Acknowledgement

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